Lengths of Lines.

MP ·1194 , MT ·1234 , PT ·1698

Inclinations to Axis of ξ.

MP 129°·39 , MT 38°·06 , PT 82°·76

From my measures:—

Lengths of Lines.

MP ·1195 , MT ·1236 , PT ·1697

Inclinations to Axis of ξ.

MP 129°·54 , MT 38°·07 , PT 82°·82

This comparison seems to justify the conclusion that my measures are subject to no serious systematic error, and to support my claim that the positions given in my previous paper are of a higher order of accuracy than those found by measuring from the limb.

These two points, Ptolemaus A and Triesnecker B, are now—next to Mösting A—the best known positions on the Moon's surface.

Professor Barnard says in the letter which accompanies his measures that he had intended to give three nights to the work, but that he found it too trying to his eyesight. The fact that under these conditions he did not stop after the first night renders the extent of my obligation to him a very great one; and I am sure that all will concur in the earnest hope that what he has so kindly done may not have impaired that well-known sensitiveness of retina of which his discoveries have given so many proofs.

On Planning Photographic Observations of Eros. Arthur R. Hinks, M.A.

1. In considering a scheme of photographic operations for the coming opposition of *Eros* the following points suggest themselves:—The planet is so faint, and its motion is so rapid, that it will be necessary with all instruments, except perhaps the largest, to follow on the planet and let the stars trail. In September and October, and again in January, the necessary exposures will run into minutes, especially since, according to Professor Pickering, the planet is photographically about $0^{m}\cdot6$ fainter than the visual magnitude.

Even at its brightest the planet will be a difficult object to follow visually in the guiding telescope ; and when it is fainter it will probably be impossible to guide upon it. Moreover, in some modern instruments the guiding telescope is dispensed with, and a star just off the edge of the plate is kept bisected in a guiding eyepiece. In such a case it is, of course, impossible to guide directly on the planet, and it will be necessary to give the plate a continuous movement whose direction and velocity are calculated beforehand.

It looks, then, as if it will be necessary in most cases to substitute guiding by calculated displacements for visual following. To meet such a contingency the screws which move the plate-holder of the Cambridge Equatorial along rectangular slides on the breech-piece of the telescope have been provided with divided heads. It would be possible to get the requisite motion of the plate by turning the heads through calculated small amounts at successive intervals of a few seconds. But to work the two slides simultaneously in this way would be too complicated. It seems to me that the better plan will be to get the trail in R.A. by adding weights to or removing them from the dish of the pendulum which controls the driving clock, after the plan described by Dr. Rambaut (" On the Inequality in the Apparent Movement of Stars due to Refraction, and a Method of allowing for it in Astronomical Photography," *Monthly Notices*, 1896, vol. lvii. p. 50). The observer will then be free to concentrate his attention on giving the motion to the declination slide.

2. In calculating the rates of displacement required we must take account of—

a. The proper motion of the planet.

b. The variation of the refraction with the hour-angle.

c. The variation of the parallactic displacement with the hour-angle.

d. The effect of any error in the adjustment of the instrumental to the true pole.

2*a.* The proper motion of the planet is given in the ephemeris by Dr. Millosevich in the *Berliner Jahrbuch* for 1902. The losing rate to be given to the clock is equal to the rate of increase of the planet's R.A.

2*b.* Let ϕ be the astronomical latitude,
δ the declination of the planet,
h its hour-angle measured west,

and let $\tan\theta = \cot\phi\cos h$.

It is easily shown that the trail in R.A. is equivalent to a losing rate of the clock of

$$24^{s}\cdot5\,\frac{\sin\theta\cos\theta}{\sin^2(\delta+\theta)}\,(\tan\delta+\cot\phi\sec h)\text{ per day.}$$

The rate of trail in declination is equivalent to a motion of

$$+15''\cdot3\cot\phi\sin h\operatorname{cosec}^2\overline{\delta+\theta}\cos^2\theta\text{ per hour.}$$

(For proof of the latter result see a paper by the writer in *Monthly Notices*, 1898, vol. lviii. p. 430.)

2*c*. Let ϕ_0 be the geocentric latitude,
Δ the distance of the planet from the Earth.

The rate of trail in R.A. is equivalent to a gaining rate of

$$3^s\cdot 69 \times 1/\Delta \times \cos\phi \cos\phi_0 \sec\delta \cos h \text{ per day,}$$

and the rate of increase of declination is

$$-2''\cdot 3 \times 1/\Delta \times \cos\phi_0 \cos\phi \sin\delta \sin h \text{ per hour.}$$

2*d*. It has been shown by the writer (*loc. cit.* pp. 429, 433) that if the instrumental is displaced from the true pole by 100″ in hour-angle H, the correction required in R.A. is equivalent to a gaining rate of the clock of

$$41^s\cdot 9 \cos(h-\mathrm{H}) \tan\delta \text{ per day,}$$

and the apparent rate of increase of declination is

$$-26''\cdot 2 \sin(h-\mathrm{H}) \text{ per hour.}$$

The rates for other displacements are proportional.

3. Take as an example the case of photographing the planet at Cambridge on September 17, 21^h W. of the meridian.

	Clock rate.	Decl. rate.
	s	″
Proper motion	−45·0	+57·1
Refraction	−22·2	− 7·5
Parallax	+ 1·8	+ 0·6
Error of pole (say 50″ in 13^h west)	−17·0	−11·4
	−82·4 per day.	+38·8 per hour.

The photographic magnitude on this day will be about $12\frac{1}{2}^m$. Suppose that it requires 10^m exposure. The displacement due to other causes than proper motion amounts to about $4\frac{1}{2}''$ during that time; and unless they are taken into account the planet will not be photographed, even if its proper motion of 1″ per minute is allowed for.

4. It is clear that to deal with *Eros* successfully requires that the instrumental adjustment shall be of great accuracy. In the case of our example, if we can rate our control pendulum perfectly, we shall have to deal with a rate in declination of 0″·65 per minute. With a half-millimetre screw and head divided into 100 parts, we shall be able to follow by turning the head three-tenths of a division every five seconds.

With the standard astrographic equatorial it would be impossible to guide visually upon a planet of magnitude $12\frac{1}{2}$. It seems that it might be well to provide such an instrument with

a slide and screw motion of the plate-holder in declination such as I have described.

The accompanying plate (Plate 17) has been drawn to help in planning the night's work. It shows for Cambridge (lat. 52° 13′) the zenith distance of the planet for every hour of the night at intervals of fourteen days, with the corresponding parallax factor; the computed photometric magnitudes, according to Pickering; the proper motion of the planet (on the scale side of one square=2″ per minute), and the limits to the observations imposed by daylight.

Cambridge Observatory:
1900 *May* 9.

Observations of the Spots and Markings on the Planet Jupiter, made at the Dearborn Observatory of North-Western University, Evanston, U.S.A. By G. W. Hough, Director.

(*Communicated by the Secretaries.*)

The spots and markings on the surface of the planet *Jupiter*, dealt with in the present paper, have been located by means of the micrometer, and, with a few exceptions, a magnifying power of 400 has been used. If a lower power, viz. 190, is employed, the finer details cannot be well seen.

Hitherto observers have confined their observations almost entirely to displacement in longitude or rotation period. I believe that displacements in both longitude and latitude are essential for the correct interpretation of the phenomena seen on the surface.

The position of a spot or marking is determined when it is wholly on the disc, but preferably near the central meridian.

An observation for position usually consists of three measures from each limb of the planet. The measures are referred to both limbs in order to eliminate the error due to irradiation, or, what is of great importance, the enlargement of the disc due to imperfect definition.

T=time of passage over the central meridian of the luminous disc, not corrected for defective illumination. The time is that of the 90th meridian, or 6 hours slow of Greenwich M.T.

β=distance from the apparent equator of the disc. After applying the correction for the elevation of the Earth above *Jupiter's* equator, the distance north or south of the equator is designated reduced latitude.

L=length of chord on middle of disc.

In the determination of rotation period the observations have been corrected for longitude of equinox, aberration time, annual parallax, and defective illumination. With the exception of the